

Table 1. Peter-Mitchel pit water levels.

The pit number correspond to the pits in the attached map.

| | <div> <div><-west</div> <div>pit</div> <div>east-></div> </div> | | | | | | | |
|----------------------------------|---|----------|--------------|------------------|---------|--------|--------|--------|
| | 8 | 7 | 6*Area3-West | 5*Area3-East | 4 Area2 | 3 | 2 | 1 |
| year | | SD011-12 | SD008-10 | SD006-7 | SD005 | SD004 | | SD002 |
| 1978/09 | | empty | ~empty | empty | empty | empty | empty | |
| 1979/09 | | empty | empty | empty | empty | empty | empty | |
| 1980/10 | | empty | empty | ~empty | empty | empty | empty | |
| 1985/10 | | ~empty | ~empty | <477.9 | ~empty | ~empty | ~empty | ~empty |
| 1986/11 | | | | 483.4 | | | | |
| 1987/09 | | | | 487.7 | | | | |
| 1988/04 | | | | 488.3 | | | | |
| 1989/10 | | | | 492.6 | 492.6 | | | |
| 1991/09 | | 499.0 | 494.0 | 494.4 | 492.6 | | | |
| 2011/05 | 498.74 | 499.50 | 494.4 | 477.6 | 460.0 | 425.1 | 452.3 | 432.7 |
| | | | | | | | | |
| Barr MODFLOW runs (1996) | 488.3 | 500.1 | 492.6 | 492.6 | missing | 475.5 | 475.5 | |
| Partridge @ SW001 | | | 489.7 | | | | | |
| confluence of Yelp and Partridge | | | 487.0 | | | | | |
| Partridge & RR grade (SW002) | | | 486.8 | | | | | |

*headwaters of Partridge River/Yelp Cr.

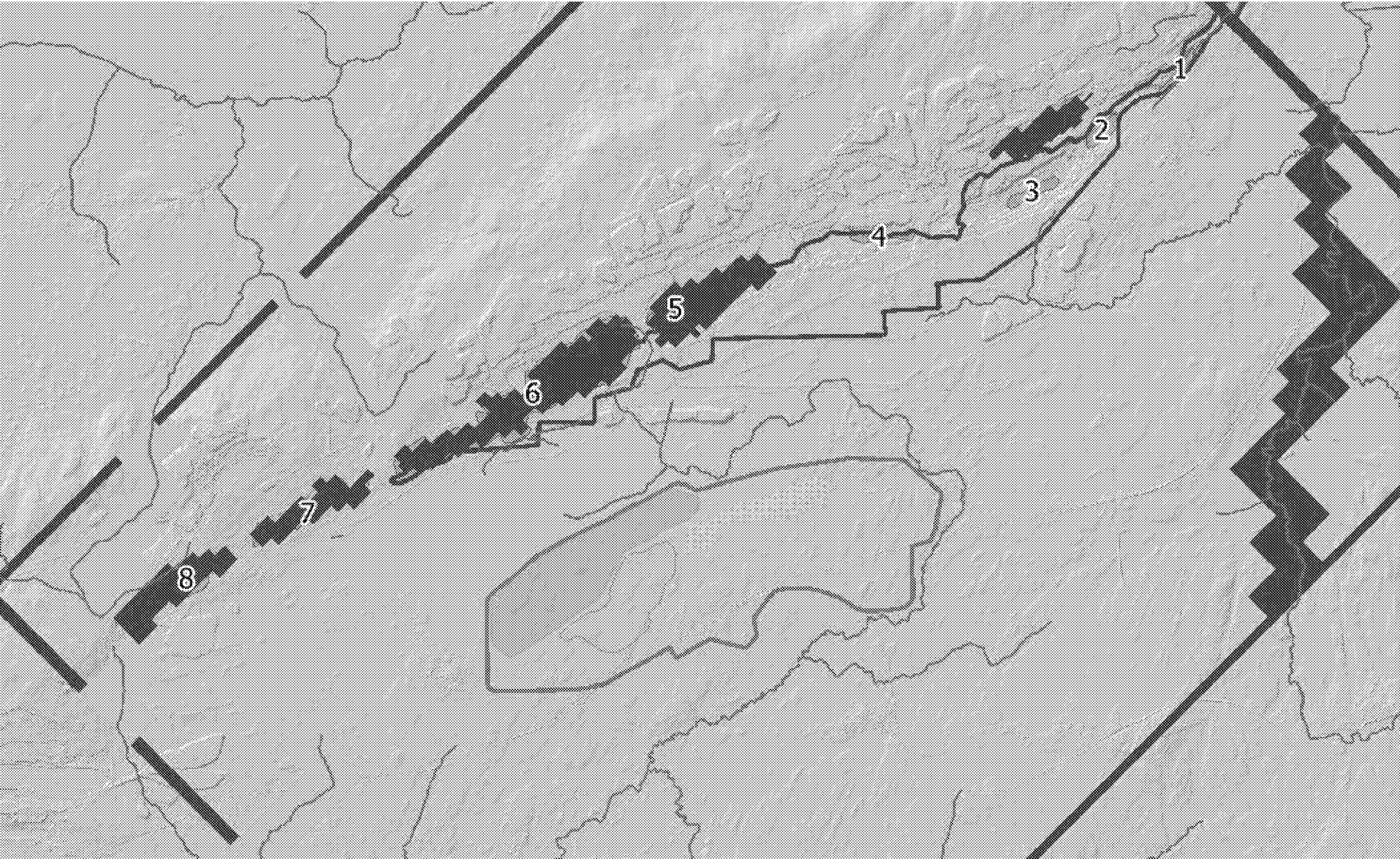


Table 2. Table 3-4 in WMDPv13

horizontal hydraulic conductivity was 4.5×10^{-4} feet/day, estimated from the five borehole tests conducted south of the proposed pits, away from the Virginia Formation contact.

3.2.5.5 Calibration Results

Optimized hydraulic conductivity values are summarized in Table 3-4. Because the horizontal hydraulic conductivity of the unconsolidated deposits varies by cell, the range of values and mean value in each zone resulting from the calibration are shown. Large Figure 18 shows the calibrated hydraulic conductivity distribution in Layer 1 for the area of interest, including the average hydraulic conductivity for each of the GoldSim groundwater flow path areas. Table 3-5 provides a comparison between the estimated and calibrated hydraulic conductivity values at locations where prior information was included in the calibration. Calibrated hydraulic conductivity values generally compare well with the estimated values.

Table 3-4 Optimized Hydraulic Conductivity Values

| Model Parameter | Value (feet/day) |
|--|---|
| Horizontal hydraulic conductivity – Upland deposits | Range: 0.056 - 167 Mean: 19.2 |
| Horizontal hydraulic conductivity – Wetland deposits | Range: 0.003 - 224 Mean: 23.7 |
| Vertical hydraulic conductivity – Upland and wetland deposits ⁽¹⁾ | 0.0028 ⁽¹⁾ |
| Hydraulic conductivity – Giants Range granite | $K_{xx} = K_{yy} = 0.029$ $K_{zz} = 0.0029$ |
| Hydraulic conductivity – Biwabik Iron Formation | $K_{xx} = K_{yy} = 0.87$ $K_{zz} = 0.087$ |
| Hydraulic conductivity – Virginia Formation, Upper Portion | $K_{xx} = K_{yy} = 0.31$ $K_{zz} = 0.031$ |
| Hydraulic conductivity – Duluth Complex | $K_{xx} = K_{yy} = 4.4 \times 10^{-4}$ $K_{zz} = 4.4 \times 10^{-5}$ |
| Hydraulic conductivity – Virginia Formation, Lower Portion | $K_{xx} = K_{yy} = 0.079$ $K_{zz} = 0.0079$ |
| Vertical hydraulic conductivity term of Partridge River Reach 1 | 41.0 |
| Vertical hydraulic conductivity term of Partridge River Reach 2 | 32.8 |
| Vertical hydraulic conductivity term of Partridge River Reach 3 | 25.6 |
| Vertical hydraulic conductivity term of Partridge River Reach 4 | 18.5 |
| Vertical hydraulic conductivity term of Partridge River Reach 5 | 13.2 |
| Vertical hydraulic conductivity term of Partridge River Reach 6 | 10.4 |
| Vertical hydraulic conductivity term of Partridge River Reach 7 | 8.8 |
| Vertical hydraulic conductivity term of Partridge River Reach 8 | 10.0 |

(1) Parameter not allowed to vary during calibration

Table 3. MODFLOW modeling results used for Goldsim modeling of contaminant transport as reported in the water modeling report "Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf".

| | |
|---|--|
| Establish general groundwater head distribution (e.g. watertable): | Section 5.2.3.7 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 124 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf and Large Figs. 14 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 492 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) |
| Establishing contaminant flow paths: | Section 5.2.3 and Large Figs. 28-29 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 114 and 511 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) and Section 5.2.3.7 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 124 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) |
| Establishing gradients along contaminant flow paths: | Section 5.2.3.1 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 118 Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) |
| Establishing hydraulic conductivity along contaminant flow paths: | Section 5.2.3.7 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 125 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) and Section 3.2.5.5 and Large Fig. 18 of Attachment B Groundwater Modeling of the NorthMet Mine Site (.pdf page 662 and 702 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) |
| "Infiltration" along contaminant flowpaths for calculation of baseflow: | Section 5.2.4.3.5 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 141 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf) |

Pit inflows used for "overall water balance in the probabilistic model" (contaminant transport model):

Section 5.2.3.7 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 125 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf)
and
Section 6.1.2.3.2 of Water Modeling Data Package Volume 1 - Mine Site (.pdf page 177 of Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf)

Table 4. Parameters used in GoldSim modeling. from the Water_Modeling_Data_Package_Vol_1-Mine_Site_v13_DEC2014.pdf

Table 1-1 Input Variables for the Mine Site Model

| Variable Name | Units | Deterministic/ Uncertain | Sampling/ Calculation Frequency | Distribution | Mean or Mode | Standard Deviation | Minimum | Maximum | Description | Source of Input Data | Modeling Package Section |
|---|----------------------|-----------------------------|---------------------------------------|---------------|---------------------------------------|-----------------------|---------|---------|---|--|---|
| Grey cells indicate changes from the previously published version | | | | | | | | | | | |
| Climatic Variables | | | | | | | | | | | |
| Annual_Precip_Cuberoot | [in ^{1/3}] | Uncertain | Annual | Trunc. Normal | 3.05 | 0.16 | 0 | N/A | Cube root of the annual precipitation | HiDen Climate network for Mine Site (1980-2010 climate normal) | Water Section 5.2.1 <i>Climate Inputs</i> |
| Monthly_Precip_Factors | [%] | Deterministic | N/A | Constant | Vector by month. Reference Table 1-11 | | | | Factors for partitioning annual precipitation to monthly | HiDen Climate network for Mine Site (1980-2010 climate normal) | Water Section 5.2.1 <i>Climate Inputs</i> |
| Annual_Evap | [in/yr] | Uncertain | Annual | Normal | 20.8 | 1.33 | N/A | N/A | Annual evaporation from open water | HiDen Climate network for Mine Site (1980-2010 climate normal); Baker (1979) | Water Section 5.2.1 <i>Climate Inputs</i> |
| Monthly_Evap_Factors | [%] | Deterministic | N/A | Constant | Vector by month. Reference Table 1-11 | | | | Factors for partitioning annual open water evaporation to monthly | Baker (1979) for partitioning ratios | Water Section 5.2.1 <i>Climate Inputs</i> |
| Snowmelt | [--] | Deterministic | N/A | Constant | 4 | N/A | N/A | N/A | Month when snowmelt occurs | USGS Gage Data | Water Section 6.1.3.3 <i>Water Balance, Mine Pits</i> |
| Freezeup | [--] | Deterministic | N/A | Constant | 11 | N/A | N/A | N/A | Month when freezeup occurs, consistent with WWTF design team definition | USGS Gage Data | Water Section 6.1.3.3 <i>Water Balance, Mine Pits</i> |

Background Chemistry

| | | | | | | | | | | | |
|-------------------|---------|---------------|-------------|--------------------|--|-----|-----|-----|---|---|---|
| GW_Conc_Surf | [mg/L] | Uncertain | Realization | Transformed Normal | Vector by Constituent. Reference Table 1-12 | | | | Surficial groundwater concentrations in the Partridge River watershed | Analysis of PolyMet background water quality data | Water Section 5.3.1 <i>Background Groundwater</i> |
| GW_Conc_Bed | [mg/L] | Uncertain | Realization | Transformed Normal | Vector by Constituent. Reference Table 1-12 | | | | Bedrock groundwater concentrations in the Partridge River watershed | Analysis of PolyMet background water quality data | Water Section 5.3.1 <i>Background Groundwater</i> |
| SW_Conc_RO | [mg/L] | Uncertain | Month | Lognormal | Vector by Constituent. Reference Table 1-13 | | | | Calibrated surface runoff concentrations in the Partridge River watershed | Calibration of model to baseline conditions | Water Section 5.3.1 <i>Background Surface Runoff</i> |
| SW_Conc_PMP | [mg/L] | Deterministic | N/A | Constant | Vector by Constituent. Reference Table 1-13 | | | | Concentration leaving the Peter Mitchell Pits | 2004-2007 WQ modeling at SW-001 | Water Section 5.5.3.1 <i>Other (Non-Project) Loads</i> |
| Flow_PMP | [cfs] | Deterministic | N/A | Constant | 2.6 | N/A | N/A | N/A | Flow from Peter Mitchell Pit dewatering to SW-001 | Calibration of model to baseline conditions | Water Section 5.5.3.1 <i>Other (Non-Project) Loads</i> |
| Flow_PMP_end | [yr] | Deterministic | N/A | Constant | 55 | N/A | N/A | N/A | Mine Year when flow from Peter Mitchell Pit ends, equivalent to year 2070 | Northshore Mine Plan | Water Section 5.5.3.1 <i>Other (Non-Project) Loads</i> |
| SW_Conc_Partridge | [mg/L] | Deterministic | N/A | Constant | Matrix by Constituent and location. Reference Table 1-14 | | | | Baseline existing chemistry in Partridge River used to evaluate model | 2004-2010 Monitoring Data of Partridge River | Water Section 4.4.4.1 <i>Water Quality ,Partridge River</i> |
| Load_Colby | [kg/yr] | Deterministic | N/A | Constant | Vector by Constituent. Reference Table 1-13 | | | | Calibrated additional loading to Colby Lake | Calibration of model to baseline conditions | Water Section 5.5.3.1 <i>Other (Non-Project) Loads</i> |

Groundwater Flowpath Characteristics

| | | | | | | | | | | | |
|------------|------|---------------|-------------|----------|--|--|--|--|---|-------------------------|--|
| L_ops | [--] | Uncertain | Realization | Uniform | Vector by flowpath. Reference Table 1-15 | | | | Average hydraulic gradient along aquifer | Mine Site MODFLOW model | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| L_closure | [--] | Uncertain | Realization | Uniform | Vector by flowpath. Reference Table 1-15 | | | | Average hydraulic gradient along aquifer in closure | Mine Site MODFLOW model | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| Thick | [m] | Deterministic | N/A | Constant | Vector by flowpath. Reference Table 1-15 | | | | Aquifer thickness | Assumed value | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| EL_Pit | [ft] | Deterministic | N/A | Constant | Vector by flowpath. Reference Table 1-15 | | | | Pit surficial outflow elevation | GIS data/calculations | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| Width | [m] | Deterministic | N/A | Constant | Vector by flowpath. Reference Table 1-15 | | | | Flowpath width | GIS data/calculations | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| L_Upstream | [m] | Deterministic | N/A | Constant | Vector by flowpath. Reference Table 1-15 | | | | Length upstream of stockpile | GIS data/calculations | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| L_Stock | [m] | Deterministic | N/A | Constant | Vector by flowpath. Reference Table 1-15 | | | | Source (stockpile) length | GIS data/calculations | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| L_Eval_1 | [m] | Deterministic | N/A | Constant | Vector by flowpath. Reference Table 1-15 | | | | Length to Evaluation Point #1 | GIS data/calculations | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| L_Eval_2 | [m] | Deterministic | N/A | Constant | Vector by flowpath. Reference Table 1-15 | | | | Length to Evaluation Point #2 | GIS data/calculations | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| L_Eval_3 | [m] | Deterministic | N/A | Constant | Vector by flowpath. Reference Table 1-15 | | | | Length to Evaluation Point #3 | GIS data/calculations | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| L_Total | [m] | Deterministic | N/A | Constant | Vector by flowpath. Reference Table 1-15 | | | | Total flowpath length | GIS data/calculations | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |

Table 4, continued.

| Table 1-1 Input Variables for the Mine Site Model | | | | | | | | | | | |
|---|-------------------|-----------------------------|---------------------------------------|--------------|--|-----------------------|---------|---------|--|--|--|
| Variable Name | Units | Deterministic/ Uncertain | Sampling/ Calculation Frequency | Distribution | Mean or Mode | Standard Deviation | Minimum | Maximum | Description | Source of Input Data | Modeling Package Section |
| Grey cells indicate changes from the previously published version | | | | | | | | | | | |
| Groundwater Flow Variables | | | | | | | | | | | |
| Bedrock_Porosity | [--] | Deterministic | N/A | Constant | 0.05 | N/A | N/A | N/A | Porosity of the bedrock flowpaths | Mine Site MODFLOW model (Bedrock units) | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| Surficial_Porosity | [--] | Deterministic | N/A | Constant | 0.3 | N/A | N/A | N/A | Porosity of the surficial flowpaths | Assumed value, e.g. Fetter, 2001 | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| K_Flowpath | [m/d] | Uncertain | Realization | Triangular | Vector by flowpath. Reference Table 1-15 | | | | Hydraulic conductivity of the surficial and bedrock material | Mine Site MODFLOW model (Duluth Complex), constraints discussed in Water Section 5.4.1 | Water Section 5.4.4 <i>Groundwater Transport in GoldSim</i> |
| Recharge_min | [in/yr] | Deterministic | N/A | Constant | 0.36 | N/A | N/A | N/A | Minimum allowed recharge in surficial aquifer (for checking calculated value) | Mine Site MODFLOW model | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| Recharge_max | [in/yr] | Deterministic | N/A | Constant | 1.8 | N/A | N/A | N/A | Maximum allowed recharge in surficial aquifer (for checking calculated value) | Mine Site MODFLOW model | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| Surficial_Density | [kg/m3] | Deterministic | N/A | Constant | 1,500 | N/A | N/A | N/A | Dry (bulk) Density of the surficial deposits | USDA St. Louis County Soil Survey Database | Water Section 5.4.1 <i>Groundwater Flowpath Modeling</i> |
| Kd_Surficial | [L/kg] | Deterministic | N/A | Constant | Vector by Constituent. Reference Table 1-16 | | | | Sorption coefficients for the surficial aquifer (As, Sb, Cu, Ni) | EPA screening-level values | Water Section 5.4.3 <i>Sorption</i> |
| Stream Reach Characteristics | | | | | | | | | | | |
| Segment_Area | [m ²] | Deterministic | N/A | Constant | Vector by location. Reference Table 1-17 | | | | Cross sectional area of each segment upstream of each node | RS26 geomorphic surveys | Water Section 5.5 <i>Surface Water Modeling</i> |
| Segment_Length | [m] | Deterministic | N/A | Constant | Vector by location. Reference Table 1-17 | | | | Length of river upstream of each node | GIS data | Water Section 5.5 <i>Surface Water Modeling</i> |
| Colby_Volume | [acre-ft] | Deterministic | N/A | Constant | 5,300 | N/A | N/A | N/A | Colby Lake storage volume from RS73B | DNR bathymetric maps (summarized in RS73B) | Water Section 6.1.5 <i>Water Balance, Colby Lake</i> |
| Contributing_Area | [acre] | Deterministic | N/A | Time Series | Matrix by location and year. Reference Table 1-18 | | | | Contributing watershed area to each river node (incremental), used to calculate recharge | XPSWMM Model GIS analysis | Water Section 5.6.4 <i>Modeling Future Conditions</i> |
| Stream Flow Variables | | | | | | | | | | | |
| Streamflow_SW006_(Month) | [cfs] | Uncertain | Timestep | User-defined | Imported from worksheet. Reference Table 1-19 | | | | Randomly sampled daily streamflow at SW-006 for each month | USGS gage data (corrected for PMP dewatering) | Water Section 5.6.5 <i>Developing Probabilistic Model Inputs</i> |
| Inc_Flow_Factor_(Month) | [--] | Deterministic | N/A | Time Series | Imported from worksheet. Reference Table 1-20a through 1-20i | | | | Factor to multiply Q at SW006 to get the incremental inflow between nodes for each month | XP-SWMM model results (relative differences) | Water Section 5.6.5 <i>Developing Probabilistic Model Inputs</i> |
| GW_Inc_Baseflow | [cfs] | Deterministic | N/A | Time Series | Imported from worksheet. Reference Table 1-21 | | | | Baseflow adding to evaluation points via natural groundwater | XP-SWMM model results scaled to observed baseflow at SW-006 | Water Section 5.6.5 <i>Developing Probabilistic Model Inputs</i> |